Life Expectancy of American Men in Relation to Their Smoking Habits [1,2]

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SUMMARY—1) Death rates were studied in relation to the smoking
habits of 447,196 men born between 1868 and 1927 and still living on
July 1, 1960. During a 5-year period (July 1, 1960, through June 30, 1965),
39,178 of the men died. Their death rates were lower than those shown in
the 1959–61 U.S. white male life table because, at the time of selection,
men too ill to answer a questionnaire and men in long-term care institu-
tions were excluded, and men in the lowest socioeconomic groups were
underrepresented in the study population. 2) Life tables were constructed
for men such as those included in the study. The estimated mean length of
life remaining at age 35 was 42.4 years for men who never smoked regu-
larly, 37.8 for those who smoked 1–9 cigarettes a day, 37.1 years for
those who smoked 10–19, 36.5 years for those who smoked 20–39, and
34.7 years for those who smoked 40+. It was 38.8 years for cigarette
smokers who began when they were between 25 and 34 years old, 37.7
years for those who began between 20 and 24 years of age, 36.0 for those
who began between the ages of 15 and 19, and 34.6 years for those who
began before the age of 15. 3) By making adjustments described in the
text, we constructed life tables by smoking habits for all U.S. white men
starting at age 35. Similarly, we constructed life tables for all U.S. men
starting at age 25. These tables are shown in the text.—J Nat Cancer Inst
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NUMEROUS prospective epidemiological studies have shown that death rates are higher among cigarette smokers than among nonsmokers and increase with amount of cigarette smoking (1–7). Thus life expectancy must be shorter for cigarette smokers than for nonsmokers and must decrease with amount of cigarette smoking. This paper estimates the life expectancy of U.S. men in relation to their smoking habits. For this purpose, it is necessary to have information on age-specific death rates in relation to smoking habits. Such information is now available for the age range 35–95.

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MATERIAL AND METHODS

Between October 1, 1959, and the early part of 1960, some 68,000 volunteer workers of the American Cancer Society, Inc., enrolled over one million men and women in a prospective epidemiological study. Over 99.4% of them were traced through September 30, 1964, and approximately 98.9% of them were traced through September 30, 1965. Although the design of the study has been described (6–11), certain details must be mentioned again.

The study area included 1,121 counties in 25 States, and the volunteer workers included all segments of the populations of the counties insofar as possible. Each volunteer was instructed to enroll about 10 families (.g., households) in each of which at least one person was over age 45. Further, it was specified that the volunteers were to enroll only families which they could trace for about 6 years; this specification excluded such groups as itinerant farm workers.

Having enrolled a family, the volunteer requested each member over the age of 30 to fill out a detailed, confidential questionnaire, which included, among other items, questions on past and present smoking habits. However, the volunteers were instructed to exclude persons who, due to serious illness, could not be expected to answer a questionnaire. With few exceptions, persons currently in hospitals were omitted; the selection on a family basis excluded persons confined in long-term care institutions of various types.

An analysis of information from the questionnaire showed that people of all educational levels were enrolled; but the subjects included proportionately fewer persons lacking a high school education and more college graduates than the general population of the United States. Due to selection by family groups, the sample contained proportionately more married than unmarried men (in relation to the U.S. population), although "single-person households" were not excluded. Although nonwhites were enrolled, they were underrepresented considerably in the sample (in relation to the U.S. population as a whole); the foreign-born were also underrepresented. The selection was such that the lowest socioeconomic groups (e.g., the indigent floater population and social derelicts) were largely, if not entirely, excluded; such groups are subject to excessively high death rates.

It is likely that selective factors were somewhat different for subjects between the ages of 30 and 44 than for those over the age of 45 because people between the ages of 30 and 44 were enrolled only if they were members of a family containing at least one person over the age of 45. Chronic illness or disability is sometimes the reason a man in his thirties continues to live with his parents or older relatives.

Due to exclusion of persons too ill to answer a questionnaire, death rates were very low during the first few months following enrollment of the subjects. This effect had diminished by July 1, 1960. Therefore, we confined the present analysis to subjects still living as of July 1, 1960. On that date, there were 447,196 male subjects who were born between 1868 and 1927 and who had satisfactorily answered the questions on their smoking habits.[3] Of these 447,196 men, 39,178 died during the 5-year period from July 1, 1960, through June 30, 1965. A few men were not traced for the full 5 years, but most of these were traced for 4 years.

The subjects were classified by 5-year date-of-birth groups: 1927–23, 1922–18, 1917–13, . . ., 1872–68. Under the fiction that all births occur on July 1, the ages of these men on July 1, 1960, were: 33–37, 38–42, 43–47, . . ., 88–92. Hereafter we will refer to these groups by the central age of the men as of July 1, 1960: 35, 40, 45, . . ., 90.

In computing, we took the death rate of the men in a particular 5-year age group to represent the death rate of men at the central age of that group. For example, we took the death rate of men aged 33–37 to represent the death rate of men who were at exact age 35 on July 1, 1960. While not precise, this computation was sufficiently close for our purpose and is preferable to an interpolated figure.

Table 1 shows for each age (as defined above) the percent of men who died during the ensuing 5 years (July 1, 1960–June 30, 1965). No adjustment was made for the slight loss to follow-up.

[3] A few county units with an enrollment of 7,917 subjects did poorly in tracing subjects during the last year of the study. These county units were excluded from the present analysis.

Table 1 also shows the corresponding percent deaths during succeeding 5-year age intervals as indicated by the 1959-61 U.S. life table for white males (12).[4] The difference in rates and the proportion (rate for subjects divided by rate for U.S. white males) are indicated in the last two columns of the table.

TABLE 1.—Percent of men in study who died during 5 years (number of deaths occurring between July 1, 1960, and June 30, 1965, divided by number of men alive on July 1, 1960) by age as of July 1, 1960. Corresponding percentages also shown for 1959-61 U.S. life table for white males

Age (yr)	Men in study (a)	U.S. white males (b)	Difference (a) − (b)	Ratio (a)/(b)
35	1.185	1.242	−0.057	0.954
40	1.575	2.049	−0.474	.769
45	2.563	3.434	−0.871	.746
50	3.826	5.675	−1.849	.674
55	6.069	8.462	−2.393	.717
60	9.773	12.785	−3.012	.764
65	14.141	18.241	−4.000	.775
70	20.408	25.301	−4.893	.807
75	28.848	35.352	−6.504	.816
80	39.774	49.737	−9.963	.800
85	56.375	64.791	−8.416	.870
90	68.617	79.217	−10.600	.866

For brevity, we will hereafter often use the term "death rate" to mean "the number of men who died during a period of 5 years divided by the number of men alive at the beginning of that period."

The death rate of the study population at all ages was less than that shown in the 1959-61 U.S. life table for white males, the difference varying with age, being slight at age 35, considerable between ages 40 and 70, and not very great at old ages. However, the difference in death rates between the study population and the total U.S. population was considerably less than that in death rates between men holding standard ordinary life insurance and the total U.S. population (2). Ordinary life insurance policy holders are selected by medical examination (screening out the unhealthy) and on an economic basis (i.e., the ability to pay the premiums). Thus it would appear that, at the time of selection, the study population was close to that of a very large segment of the white U.S. male

population—men living at home (i.e., not institutionalized), excluding those extremely ill at a given time and men at the bottom of the socio-economic scale. Men in this segment of the population have lower death rates than those for the total population.

RESULTS

Death Rates by Smoking Habits

Since so few of the subjects under 50 had a history of only pipe smoking or only cigar smoking, their death rates were unstable statistically. Thus men who smoked only pipes or cigars were excluded from the present analysis.

Table 2 shows, for each age group, the percent of men who died within the 5-year period for: a) men who never smoked regularly and b) men who were currently smoking cigarettes at the time of enrollment classified by the number of cigarettes they were currently smoking per day. Since we were interested in the life expectancy of continuing cigarette smokers starting at age 35, we omitted from this analysis men who did not start to smoke cigarettes until after the age of 35. Table 3 shows the corresponding figures for: a) men who never smoked regularly and b) men who were currently smoking cigarettes at the time of enrollment classified by the age at which they began to smoke cigarettes.

There were few subjects in some groups, and in these groups the death rates were unstable statistically. Certain of these unstable rates were inconsistent with the data as a whole, some on the high side and some on the low. Therefore, we adjusted these rates to bring them more in line. Rates so adjusted are indicated in tables 2 and 3. This adjustment had only a trivial effect on life-expectancy computations based on these figures. In age group 90, there were few cigarette smokers; but if one disregards amount of smoking, their death rate was somewhat higher than that of men who never smoked regularly. However, for our purpose, we assumed that, after the age of 90, death rates were unrelated to smoking habits.

[4] White U.S. males were used for comparison because there were relatively few nonwhite subjects in the study. Death rates shown for the study population would have been changed only slightly by excluding nonwhite subjects.

TABLE 2.—Percent of men dying in 5 years, difference in percentages, and mortality ratios by age. Men who never smoked regularly compared with cigarette smokers classified by amount of smoking

Age (yr)	Never smoked regularly	Smokers: No. of cigarettes smoked a day			
		1-9	10-19	20-39	40+
	a) Percent of men who died in 5 years				
35	0.730*	1.280*	1.306	1.330	1.871
40	0.917	1.740*	1.820*	1.933	3.167
45	1.352	2.703	3.044	3.437	4.383
50	2.121	3.251	4.490	5.003	6.208
55	3.877	6.560	7.097	7.669	9.793
60	6.479	10.005	11.912	12.871	14.985
65	10.454	17.133	19.350	19.319	20.237
70	17.040	25.087	24.422	27.763	29.268
75	26.179	35.881	36.944	33.445	37.079
80	37.059	53.247	44.118	49.153	44.500*
85	56.042	61.818	65.000*	61.500	60.000*
90	68.617†	68.617†	68.617†	68.617†	68.617†
	b) Difference in percent deaths (percent for smokers minus percent for men who never smoked regularly)				
35	...†	...	...	...	...
40	0.000	...	...	1.016	2.250
45	.000	1.351	1.692	2.085	3.031
50	.000	1.130	2.369	2.882	4.087
55	.000	2.683	3.220	3.792	5.916
60	.000	3.526	5.433	6.392	8.506
65	.000	6.679	8.896	8.865	9.783
70	.000	8.047	7.382	10.723	12.228
75	.000	9.702	10.765	7.266	10.900
80	.000	16.188	7.059	12.094	...
85	.000	5.776	...	...	...
90	...	...	...	...	...
	c) Mortality ratio (percent for smokers divided by percent for men who never smoked regularly)				
35	...	...	...	...	...†
40	1.00	...	...	2.11	3.45
45	1.00	2.00	2.25	2.54	3.24
50	1.00	1.53	2.12	2.36	2.93
55	1.00	1.69	1.83	1.98	2.53
60	1.00	1.54	1.84	1.99	2.31
65	1.00	1.64	1.85	1.85	1.94
70	1.00	1.47	1.43	1.63	1.72
75	1.00	1.37	1.41	1.23	1.42
80	1.00	1.44	1.19	1.33	...
85	1.00	1.10	...	...	...
90	...	...	...	...	...

*Adjusted percent.
†Percent for all men of age group.
‡Difference or mortality ratio involving adjusted percent or percent for all men of age group is shown as ... .

These adjustments made little difference in the computation of life expectancy, since they were confined to the youngest age groups (where death rates are low) and to the oldest age groups (where survivors are few).

Adjustment of Death Rates

As table 1 shows, death rates in the study population were lower than those reported for the total U.S. white male population. Presumably, this was because, at the time of selection, the study population contained proportionately fewer men with conditions (or subjected to conditions) which could eventuate in death. For purposes at hand, we had to estimate death rates in the total U.S. white male population in relation to smoking habits. Two methods for estimation were considered, based on two different assumptions.

Additive assumption.—Let D stand for the differ-

TABLE 3.—Percent of men dying in 5 years, difference in percentages, and mortality ratios by age. Men who never smoked regularly compared with cigarette smokers classified by ages began cigarette smoking

Age (yr)	Never smoked regularly	Smokers: Age began cigarette smoking (yr)			
		25–34	20–24	15–19	<15
a) Percent of men who died in 5 years					
35	0.730*	0.870*	1.090*	1.274	1.917
40	0.971	1.190*	1.479	2.154	2.824
45	1.352	2.404	2.887	3.683	4.045
50	2.121	3.513	4.374	5.140	6.223
55	3.877	6.503	6.676	8.019	9.772
60	6.479	11.393	11.571	13.080	13.762
65	10.454	16.895	16.822	20.007	22.354
70	17.040	21.059	25.132	26.852	31.269
75	26.179	30.120	34.194	36.663	35.917
80	37.059	46.809	45.033	51.493	47.619
85	56.042	56.000*	61.538	69.355	65.000*
90	68.617†	68.617†	68.617†	68.617†	68.617†
b) Difference in percent deaths (percent for smokers minus percent for men who never smoked regularly)					
35	...‡	...	...	...	...
40	0.000	...	0.562	1.237	1.907
45	.000	1.052	1.535	2.331	2.693
50	.000	1.392	2.253	3.019	4.107
55	.000	2.626	2.799	4.142	5.895
60	.000	4.914	5.092	6.601	7.283
65	.000	6.441	6.368	9.553	11.900
70	.000	4.019	8.092	9.812	14.229
75	.000	3.941	8.735	10.484	9.738
80	.000	9.750	7.974	14.434	10.560
85	.000	...	5.496	13.313	...
90	...	...	...	...	...
c) Mortality ratio (percent for smokers divided by percent for men who never smoked regularly)					
35	...	...	...	...	...
40	1.00	...	1.61	2.35	3.08
45	1.00	1.78	2.14	2.72	2.99
50	1.00	1.66	2.06	2.42	2.94
55	1.00	1.68	1.72	2.07	2.52
60	1.00	1.76	1.79	2.02	2.12
65	1.00	1.62	1.61	1.91	2.14
70	1.00	1.24	1.47	1.58	1.84
75	1.00	1.15	1.33	1.40	1.37
80	1.00	1.26	1.22	1.39	1.28
85	1.00	...	1.10	1.24	...
90	...	...	...	...	...

* Adjusted percent.
† Percent for all men of age group.
‡ Difference or mortality ratio involving adjusted percent or percent for all men of age group is shown as ....

ence between the death rate of all men in the study and the death rate of men of the same age in the general population. Assume that this difference applies equally to nonsmokers and to each class of smokers. Then we should add D to the death rate of nonsmokers and each class of smokers in the study to estimate death rates in the general population in relation to smoking habits.

Proportional assumption.—Let R stand for the ratio: death rate of men in the general population

divided by death rate of all men of the same age in the study. Assume that this ratio applies equally to nonsmokers and to each class of smokers. Then we would multiply the death rate of nonsmokers and each class of smokers by R.

Since these two assumptions led to somewhat different estimates, we sought to determine which of the two was more likely to be correct.

Part b of tables 2 and 3 shows the difference between the death rate of cigarette smokers and

the death rate of men who never smoked regularly (*i.e.*, the death rate of cigarette smokers minus the death rate of men who never smoked regularly). Hereafter, we will refer to this as the "mortality difference." Part *c* of tables 2 and 3 shows the mortality ratio in relation to cigarette smoking (*i.e.*, the death rate of cigarette smokers divided by the death rate of men who never smoked regularly). The mortality differences increased greatly with advancing age, whereas the mortality ratios decreased with advancing age.

As age increases, there is an increase in the prevalence and severity of conditions which can eventuate in death; as age increases, death rates increase. Therefore, the findings shown in tables 2 and 3 could mean that, as the prevalence of conditions which can lead to death increases (and death rates increase), mortality differences increase while mortality ratios decrease.

Suppose that we had detailed information on death rates in relation to the smoking habits of men in a particular 5-year age group, but only had information on the death rate of all men in the next older 5-year age group. Further, suppose that from these data we wished to estimate death rates by smoking habits for men in the older of the two age groups. We tested this on our data, first making estimates under the additive assumption and then under the proportional assumption. In almost all instances, the observed death rate of men in a particular smoking category in the older age group was between the estimate made under the additive assumption and the estimate made under the proportional assumption. This was to be expected because mortality differences increase with age whereas mortality ratios decrease with age.

We found that we could make better estimates by using the following equation:

$$Y = kA + (1 - k)P$$

where *Y* is the estimated death rate of men in a particular smoking class in the older age group, *A* is the estimate made under the additive assumption, *P* is the estimate made under the proportional assumption, and *k* is a constant. We then estimated the value of *k* by least-squares fitting procedures. The value of *k* varied somewhat with age and somewhat with smoking habits. However, *k* = 0.35

yielded good estimates, both for men who never smoked regularly and for men who smoked 40+ cigarettes a day.

We made this analysis with the thought that extrapolating from one 5-year age group to the next older 5-year age group presents some of the same problems as extrapolating from our study population to the U.S. white male population as a whole. In both cases, the problem is to extrapolate from one population to another with higher overall death rates. We know that the older group in each pair of 5-year age groups contained proportionally somewhat fewer cigarette smokers (particularly heavy cigarette smokers) than the younger group; but we did not use this information in making the extrapolation. We do not know the smoking habits of men excluded from our study, but it seems certain that this group of men consisted of nonsmokers and all types of smokers. The excluded group must have had higher death rates than the included group; judging from the distribution of deaths by causes of death in the United States, it must have had higher death rates from diseases such as heart and circulatory diseases and cancer. An analysis of our data showed a high degree of relationship between cigarette smoking and death rates of men with a history of such diseases (*6, 8*). Certain groups were underrepresented in our study. The largest such group appears to have been men who did not go to high school; we found a high degree of relationship between cigarette smoking and death rates among these men (*6*). Therefore, underrepresentation (distinguished from exclusion) of certain segments of the population could not have had much influence on the findings.

Considering this, we used the equation $Y = 0.35 A + 0.65 P$ to estimate age-specific death rates (*i.e.*, percent dying in a 5-year period) of men who never smoked regularly and of each class of cigarette smoker in the total U.S. white male population. All data used in making these estimates are shown in tables 1, 2, and 3. Life tables were then constructed from these rates. Since we lacked information for ages over 95, we assumed that all men reaching 95 had a remaining life expectancy of 2.43 years, this being the value given in the 1959–61 U.S. life table for white males.

Life Tables

Tables 4 and 5 show life tables starting at age 35, part *a* being for men such as those who were enrolled in our study and part *b* being estimates for the white male population of the United States as a whole. Our study population included men of all racial groups; but Negroes were under-represented in relation to their proportion in the total U.S. population. The figures in the body of the tables show the percent of men living to age 35 who might be expected to be still living up to each specified older age. The first figure at the bottom of each column, "Life expectancy (age)," indicates the mean age of death. The second figure, "Life expectancy (yr)," indicates the mean number of years of life remaining to men after reaching age 35. The last figure at the bottom of each column, "Difference from N.S.R. (yr)," shows the difference between the life expectancy of men who never smoked regularly and the life expectancy of each of the other groups; it indicates the number of years of life lost as a result of cigarette smoking.

Within each category, life expectancy is greater for men in the study than for white men in the United States as a whole; but the differences in life expectancy (nonsmokers compared with cigarette smokers) are about the same. For brevity, we will discuss only the total white male population as shown in part *b* of tables 4 and 5.

TABLE 4.—Survivorship of men aged 35 in relation to daily amount of cigarette smoking

Age (yr)	All men (%)	Never smoked regularly (%)	Smokers: Current No. of cigarettes per day			
			1–9 (%)	10–19 (%)	20–39 (%)	40+ (%)
a) Based on death rates of study population						
35	100.0	100.0	100.0	100.0	100.0	100.0
40	98.8	99.3	98.7	98.7	98.7	98.1
45	97.3	98.4	97.0	96.9	96.8	95.0
50	94.8	97.0	94.4	93.9	93.4	90.9
55	91.1	95.0	91.3	89.7	88.8	85.2
60	85.6	91.3	85.3	83.4	82.0	76.9
65	77.2	85.4	76.8	73.4	71.4	65.4
70	66.3	76.5	63.6	59.2	57.6	52.1
75	52.8	63.4	47.7	44.8	41.6	36.9
80	37.6	46.8	30.6	28.2	27.7	23.2
85	22.6	29.5	14.3	15.8	14.1	12.9
90	9.9	13.0	5.5	5.5	5.4	5.2
95	3.1	4.1	1.7	1.7	1.7	1.6
Life expectancy (age)	74.3	77.4	72.8	72.1	71.5	69.7
Life expectancy (yr)	39.3	42.4	37.8	37.1	36.5	34.7
Difference from N.S.R. (yr)	3.1	0	4.6	5.3	5.9	7.7
b) Based on rates adjusted to 1959–61 U.S. life table for white males						
35	100.0	100.0	100.0	100.0	100.0	100.0
40	98.8	99.2	98.7	98.6	98.6	98.1
45	96.7	98.0	96.4	96.3	96.2	94.2
50	93.4	96.1	93.0	92.5	91.8	88.8
55	88.1	92.8	88.4	86.4	85.2	81.0
60	80.7	87.5	80.4	78.0	76.3	70.4
65	70.3	79.7	69.9	66.0	63.7	57.0
70	57.5	63.7	54.6	49.9	48.2	42.5
75	43.0	54.0	37.8	34.9	31.9	27.4
80	27.8	36.6	21.4	19.3	18.9	14.3
85	14.0	19.5	7.4	8.7	7.4	6.4
90	4.9	6.9	2.2	2.3	2.3	2.0
95	1.0	1.4	0.5	0.5	0.5	0.4
Life expectancy (age)	71.3	74.5	70.1	69.2	68.6	66.7
Life expectancy (yr)	36.3	39.5	35.1	34.2	33.6	31.7
Difference from N.S.R. (yr)	3.2	0	4.4	5.3	5.9	7.8

TABLE 5.—Survivorship of men aged 35 in relation to age began cigarette smoking

Age (yr)	All men (%)	Never smoked regularly (%)	Smokers: Age (yr) began cigarette smoking			
			25-34 (%)	20-24 (%)	15-19 (%)	<15 (%)
a) Based on death rates of study population						
35	100.0	100.0	100.0	100.0	100.0	100.0
40	98.8	99.3	99.1	98.9	98.7	98.1
45	97.3	98.4	98.0	97.4	96.6	95.3
50	94.8	97.0	95.6	94.6	93.0	91.5
55	91.1	95.0	92.2	90.5	88.3	85.8
60	85.6	91.3	86.2	84.5	81.2	77.4
65	77.2	85.4	76.4	74.7	70.6	66.7
70	66.3	76.5	63.5	62.1	56.4	51.8
75	52.8	63.4	50.1	46.5	41.3	35.6
80	37.6	46.8	35.0	30.3	26.2	22.8
85	22.6	29.5	18.6	16.6	12.7	12.0
90	9.9	13.0	8.2	6.4	3.9	4.2
95	3.1	4.1	2.6	2.0	1.2	1.3
Life expectancy (age)	74.3	77.4	73.8	72.7	71.0	69.6
Life expectancy (yr)	39.3	42.4	38.8	37.7	36.0	34.6
Difference from N.S.R. (yr)	3.1	0	3.6	4.7	6.4	7.8
b) Based on rates adjusted to 1959–61 U.S. life table for white males						
35	100.0	100.0	100.0	100.0	100.0	100.0
40	98.8	99.2	99.1	98.9	98.7	98.0
45	96.7	98.0	97.5	96.9	96.0	94.5
50	93.4	96.1	94.3	93.2	91.4	89.6
55	88.1	92.8	89.4	87.3	84.6	81.7
60	80.7	87.5	81.3	79.2	75.4	71.0
65	70.3	79.7	69.4	67.4	62.7	58.5
70	57.5	68.7	54.4	52.9	46.9	42.1
75	43.0	54.0	40.3	36.7	31.6	26.2
80	27.8	36.6	25.4	21.1	17.6	14.8
85	14.0	19.5	10.7	9.3	6.4	6.1
90	4.9	6.9	3.8	2.8	1.4	1.6
95	1.0	1.4	0.8	0.6	0.3	0.3
Life expectancy (age)	71.3	74.5	70.8	69.8	68.2	66.8
Life expectancy (yr)	36.3	39.5	35.8	34.8	33.2	31.8
Difference from N.S.R. (yr)	3.2	0	3.7	4.7	6.3	7.7

Table 4 shows life expectancy for men who never smoked regularly and for continuing cigarette smokers classified by current number of cigarettes smoked per day. The second column of part *b* headed "All men (%)" was computed from the 1959–61 U.S. life table for white males.

The estimated mean length of life remaining to men then 35 years old was 39.5 years for men who never smoked regularly, 35.1 years for men who smoked 1–9 cigarettes a day, 34.2 years for men who smoked 10–19 cigarettes a day, 33.6 years for men who smoked 20–39 cigarettes a day, and 31.7 years for men who smoked 40+ cigarettes a day. Thus, on the average, the heaviest cigarette smokers may expect 7.8 less years of life than men who never smoked regularly. Since nonsmokers have 39.5 years of life expectancy and the heaviest cigarette smokers only 31.7 years, it may be said that heavy cigarette smoking results in a 20% reduction in years of life still remain at age 35. A large proportion of all cigarette smokers smoke 20–39 cigarettes a day, and they incur a 15% reduction in remaining years of life. It would appear that men who smoke 1–9 cigarettes a day incur an 11% reduction in remaining years of life at age 35.

A comment should be made about the figures just presented. When a heavy cigarette smoker becomes ill or has a heart attack, he is likely to reduce temporarily the number of cigarettes he smokes per day (*8*). Thus, when men are classified by their current smoking habits, some heavy cigarette smokers who are ill or who have recently had a heart attack are classified as light smokers.

This artifically increases the death rate of men classified as light smokers and correspondingly reduces the death rate of men classified as heavy smokers. Thus, it is likely that the figures shown in tables 4 and 5 somewhat underestimate the impact of heavy cigarette smoking and somewhat overestimate the impact of light cigarette smoking in relation to reduction in life expectancy.

Table 5 shows life expectancy for continuing cigarette smokers classified by the age at which they took up the habit. This index has the advantage that it is not subject to changes dependent on the later state of health of the individual. Furthermore, men who began smoking cigarettes early in their youth tend to smoke more cigarettes per day and to inhale the smoke more deeply than those who took up the habit later in life (7, 10). Thus the age at which a person starts to smoke cigarettes is a basic factor having considerable influence on other factors related to total lifetime exposure to cigarette smoke.

Thirty-five-year-old men who began cigarette smoking before age 15 had an estimated mean remaining life expectancy of only 31.8 years, this being 7.7 years or 19% less than the remaining life expectancy of 35-year-old men who never smoked regularly. In contrast, those who began cigarette smoking when they were between ages 25 and 34 had a mean remaining life expectancy of 35.8 years, 3.7 years or 9% less than the remaining life expectancy of men who never smoked regularly.

Magnitude of the Problem

In the paragraph above, we contrasted the life expectancy of cigarette smokers with that of men who never smoked regularly. This comparison is meaningful from the standpoint of the individual. Now let us consider the impact of cigarette smoking on the white male population of the United States as a whole. This is of interest in terms of judging the national magnitude of the problem. It depends on the number of men in each age group who smoke cigarettes, the number they smoke per day, and the ages at which they started to smoke. Therefore, the magnitude of the problem will increase if the per capita consumption of cigarettes increases and if children

start the habit at younger ages than in the past; it will diminish if the reverse occurs.

As shown in part *b* of tables 4 and 5, in 1959–61, the remaining life expectancy of 35-year-old white men in the United States was 36.3 years. This figure is based on the death rates of all white males including nonsmokers, cigarette smokers, exsmokers, pipe smokers, and cigar smokers. In contrast, the remaining life expectancy of 35-year-old white men who never smoked regularly was 39.5 years. Thus, at age 35, the overall reduction in life expectancy associated with smoking was 3.2 years or 8%. Virtually all this reduction is associated with cigarette smoking, since the death rates of pipe and cigar smokers are close to those of men who never smoked regularly.
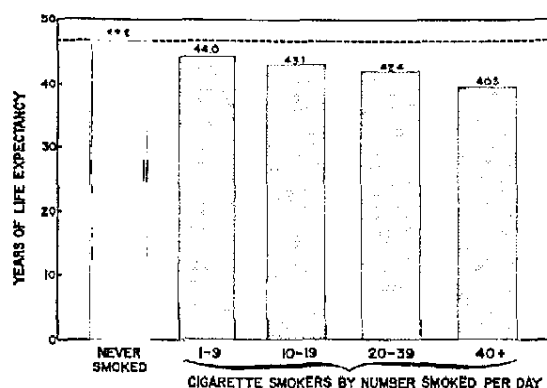
It would be desirable to have life tables by smoking habits for the entire U.S. male population starting at an age younger than 35. There are two difficulties. First, Negro men, considerably underrepresented in our study population, in the population as a whole have higher death rates than white men. This is probably not a serious difficulty, since we found that the relationship between smoking habits and death rates was essentially the same for Negro men as for white men. Second, we lack information on men under age 35. This is a great difficulty.

Within the age range our study covered, we found that mortality ratios decrease with advancing age; so it might be assumed that males younger than those included in our study have higher mortality ratios than the youngest group studied. However, we doubt that this applies to very young groups because a large proportion of deaths among young males are due to accidents and diseases not related to smoking habits. Therefore, it would be conservative to assume that mortality ratios are somewhat lower at age 30 than at age 35 and still lower at age 25. This assumption might lead to an underestimate of the effect of cigarette smoking on life expectancy. However, death rates at ages 25 and 30 are so low that an error in judgement in this respect would not greatly affect the estimate.
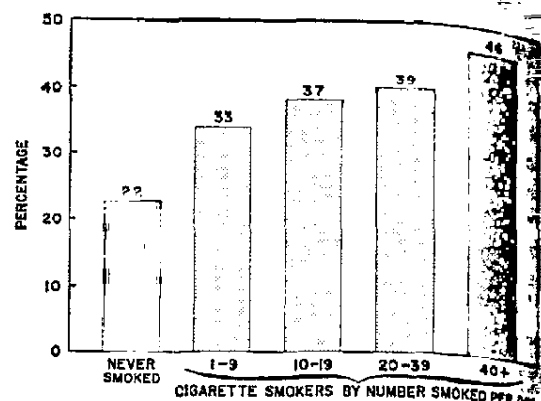
Tables 6 and 7 show life tables constructed for the U.S. male population by smoking habits starting at age 25. They are based on findings in our study adjusted to the 1959–61 U.S. life table for all males by the use of the equation previously

described. Death rates by smoking habits for ages 25 and 30 were estimated under the assumption outlined above. Text-figures 1 and 2 are based on data in table 6.

Table 8 shows estimates of the mean years of life remaining to men of various ages, for men who never smoked regularly, and for continuing ciga-rette smokers classified by number of cigarettes smoked per day.

TEXT-FIGURE 1.—Years of life expectancy of males aged 25 in relation to cigarette smoking.

TEXT-FIGURE 2.—Percentage of males aged 25 expected to die before 65 in relation to cigarette smoking.

DISCUSSION

In the biological sciences, studies and experi-ments must be carried out on some selected group of animals or human beings under some particular set of conditions. However, more often than not the purpose of a study or experiment is to obtain information concerning groups other than the group actually studied and under nonidentical

TABLE 6 —Survivorship of men aged 25 in relation to current number of cigarettes smoked per day: Based on rate adjusted to the 1959-61 U.S. life table for all males

Age (yr)	All men (%)	Never smoked regularly (%)	Smokers: Current No. of cigarettes per day			
			1-9 (%)	10-19 (%)	20-39 (%)	40+ (%)
25	100.0	100.0	100.0	100.0	100.0	100.0
30	99.1	99.4	99.1	99.1	99.1	98.8
35	98.2	98.7	98.1	98.1	98.0	97.3
40	96.8	97.8	96.6	96.5	96.5	95.1
45	94.6	96.4	94.2	94.0	93.8	91.0
50	91.1	94.4	90.6	90.0	89.3	85.6
55	85.6	90.9	85.9	83.8	82.5	77.7
60	78.1	85.5	77.8	75.3	73.5	67.1
65	67.8	77.7	67.3	63.4	61.1	54.0
70	55.2	66.7	52.4	47.7	45.9	40.0
75	41.2	52.3	36.2	33.3	30.3	25.7
80	26.7	35.6	20.6	18.6	18.1	14.3
85	13.6	19.2	7.3	8.5	7.2	6.5
90	4.9	7.0	2.2	2.2	2.2	2.1
95	1.0	1.5	0.5	0.5	0.5	0.4
Life expectancy (age)	70.2	73.6	69.0	68.1	67.4	65.3
Life expectancy (yr)	45.2	48.6	44.0	43.1	42.4	40.3
Difference from N.S.R. (yr)	3.4	0	4.6	5.5	6.2	8.3

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TABLE 7.—Survivorship of men aged 25 in relation to age began cigarette smoking: Based on rates adjusted to the 1959-61 U.S. life table for all males

Age (yr)	All men (%)	Never smoked regularly (%)	Smokers: Age began cigarette smoking (yr)			
			25-34 (%)	20-24 (%)	15-19 (%)	<15 (%)
25	100. 0	100. 0	100. 0	100. 0	100. 0	100. 0
30	99. 1	99. 4	99. 4	99. 3	99. 1	98. 8
35	98. 2	98. 7	98. 6	98. 3	98. 1	97. 3
40	96. 8	97. 8	97. 6	97. 0	96. 6	95. 2
45	94. 6	96. 4	95. 8	95. 0	93. 7	· 91. 5
50	91. 1	94. 4	92. 5	91. 1	88. 9	86. 4
55	85. 6	90. 9	87. 4	84. 9	82. 0	78. 4
60	78. 1	85. 5	79. 2	76. 8	72. 7	67. 7
65	67. 8	77. 7	67. 2	65. 0	60. 2	55. 5
70	55. 2	66. 7	52. 5	50. 8	44. 7	39. 7
75	41. 2	52. 3	38. 7	35. 1	30. 0	24. 6
80	26. 7	35. 6	24. 6	20. 4	16. 8	14. 0
85	13. 6	19. 2	10. 5	9. 1	6. 3	5. 8
90	4. 9	7. 0	3. 8	2. 8	1. 4	1. 5
95	1. 0	1. 5	0. 8	0. 6	0. 3	0. 3
Life expectancy (age)	70. 2	73. 6	69. 9	68. 8	67. 1	65. 4
Life expectancy (yr)	45. 2	48. 6	44. 9	43. 8	42. 1	40. 4
Difference from N.S.R. (yr)	3. 4	0	3. 7	4. 8	6. 5	8. 2

TABLE 8.—Life expectancy (yr) at various ages: Estimate for U.S. males

Age (yr)	Never smoked regularly	Cigarette smokers by daily amount			
		1-9	10-19	20-39	40+
25	48. 6	44. 0	43. 1	42. 4	40. 3
30	43. 9	39. 3	38. 4	37. 8	35. 8
35	39. 2	34. 7	33. 8	33. 2	31. 3
40	34. 5	30. 2	29. 3	28. 7	26. 9
45	30. 0	25. 9	25. 0	24. 4	23. 0
50	25. 6	21. 8	21. 0	20. 5	19. 3
55	21. 4	17. 9	17. 4	17. 0	16. 0
60	17. 6	14. 5	14. 1	13. 7	13. 2
65	14. 1	11. 3	11. 2	11. 0	10. 7

conditions. For example, drugs are tested for toxicity on animals before being tested on human beings; but sometimes a drug not toxic to animals is toxic to human beings or some particular set of human beings (e.g., people with serious kidney disease). In general, the closer the resemblance between the group studied and the target group, the greater is the likelihood that the study findings apply to the target group.

In this case, we believe that the life tables constructed from findings in our study population apply with reasonable accuracy to a large segment of the white male population of the United States. The segment consists of men who are not too ill

to answer a questionnaire, who are not confined to a hospital or nursing home, and who are not at the bottom of the socioeconomic scale.

How accurate are our estimates for the total U.S. white male population? More particularly, have we overestimated or underestimated the difference in life expectancy between nonsmokers and cigarette smokers in the general U.S. white male population?

One of the implied assumptions in making our estimates was that the distribution by smoking habits was the same for men excluded from our study as for men included in our study. The principal groups excluded were: 1) men confined to hospitals and nursing homes and those too ill to answer a questionnaire (groups with high death rates) and 2) men in the lowest socioeconomic groups (these having higher-than-average death rates).

Evidence from our study indicates that heavy cigarette smokers are more likely to be hospitalized during a given interval than are nonsmokers (6). Thus, proportionally, more sick cigarette smokers than sick nonsmokers were excluded from the study. If so, then this would bias our estimates in the direction of underestimating the difference in life expectancy between cigarette smokers and nonsmokers.

We did not know the smoking habits of men in the lowest socioeconomic groups who were excluded from our study. We assumed that their smoking habits were the same as for the men included in our study. However, we assumed that cigarette smoking has a smaller *relative* effect on the life expectancy of the excluded group than on the included group. Possibly, this combination of assumptions leads to an underestimate of the impact of cigarette smoking upon life expectancy; it is unlikely that it could have led to a significant overestimate.

Now let me consider the further extrapolation from the white male population to the total male population. This could have introduced an appreciable error if cigarette smoking is unrelated to the life expectancy of Negroes. Unfortunately, there were too few Negro men in our study to compute accurate life tables for them by smoking habits. However, we found that the age-standardized death rates of Negro cigarette smokers were higher than those of Negro nonsmokers (6). Furthermore, in an autopsy study, it was found that the association between cigarette smoking and changes in lung parenchyma was the same for Negroes as for whites (13). The method used in making the estimates implied that the *relative* effect of cigarette smoking on life expectancy is less on Negro men than on white men.

Considering the above, we doubt that we could have seriously overestimated the difference in life expectancy between cigarette smokers and non-smokers when we extrapolated findings from our study to the total white male population and then to the total male population of the United States.

One final word should be said. Cigarettes with reduced tar and nicotine content have become more popular since subjects were enrolled in our study. Furthermore, with the passage of time, other changes have taken place in the United States. We will not hazard a guess as to how greatly these changes may have altered the degree of association between cigarette smoking and life expectancy.

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